RS9110-N-11-21 – Serial-to-Wi-Fi Module Datasheet

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Overview

The RS9110-N-11-21 module from Redpine's Connect-io-n™ family of products is a complete IEEE 802.11bgn Wi-Fi client device with a standard serial or SPI interface to a host processor or data source. It integrates a MAC, Baseband processor, RF transceiver with power amplifier, a frequency reference, an antenna, and all WLAN protocol and configuration functionality in embedded firmware to provide a self-contained 802.11n WLAN solution. No WLAN driver functionality is required on the host processor. It is designed to provide standards compliant wireless connectivity to devices and systems that have a serial port and implement a TCP/IP stack. It uniquely provides connectivity in the single stream 802.11n mode, preserving overall network throughput in the emerging enterprise environments.

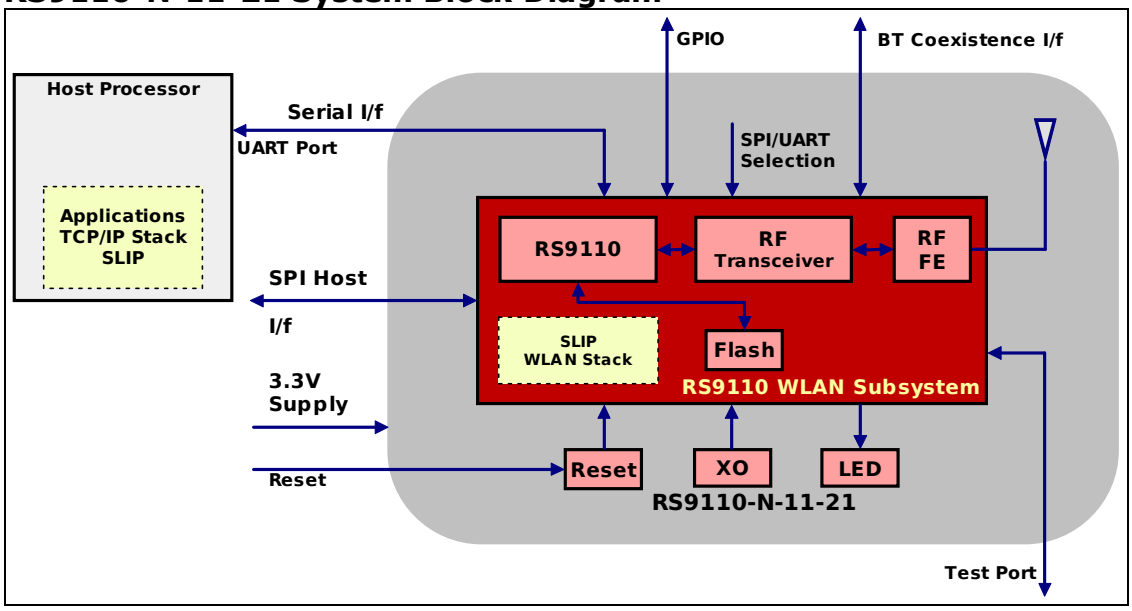
Applications:

- Seamless Wi-Fi Connectivity for Applications Processors
- Point of Sale Terminals
- Metering (Parking Meters, Utility Meters, etc.)
- Warehousing, Logistics and Freight Management
- Several medical applications including Patient Monitoring, Remote Diagnostics

Device Features:

- Compliant to 802.11b/g and single stream draft 802.11n
- Does not require any WLAN driver on the host processor
- Includes all the protocol and configuration functions required for WLAN connectivity in Open and WPA/WPA2-PSK (AES)modes of operation
- Host interface through Serial Interface and SPI
- Terminates SLIP connections and offers transparent serial modem functionality
- Configuration through UART/SPI
- Integrated antenna, frequency reference, and low-frequency clock
- Ultra low power operation with power save modes
- Ad-hoc and infrastructure modes for maximum deployment flexibility
- Single supply 3.1 to 3.6V operation

RS9110-N-11-21 System Block Diagram



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1: Detailed Feature List

1.1: Host Interfaces

- UART
  - The UART forms the physical layer of the TCP/IP stack carrying SLIP-encapsulated frames
  - The UART interface supports variable baud rates from 9600 to 3686400 bps
  - AT Command Interface for configurable parameters
- SPI
  - Standard 4-wire SPI
  - Operation up to a maximum clock speed of 80MHz[1]

1.2: General Purpose Input/Output

- Six dedicated GPIO pins[2]
- Nine pins with alternate functions that can be configured as GPIO pins
- Each GPIO can be programmed as input or output
- Each GPIO pin supports sensing of Rising and/or Falling edges
- GPIO pins can be controlled from the Host

1.3: WLAN

1.3.1: MAC

- Conforms to IEEE 802.11b/g/n standards for MAC
- Dynamic selection of fragment threshold, data rate, and antenna depending on the channel statistics
- QoS support
- Infrastructure and Ad-hoc modes
- WPA/WPA2-PSK supplicant

1.3.2: Baseband Processing

- Supports DSSS (1, 2 Mbps) and CCK (5.5, 11 Mbps) modes
- Supports all OFDM data rates (6, 9, 12, 18, 24, 36, 48, and 54 Mbps)
- Supports IEEE 802.11n single-stream modes with data rates up to 65 Mbps
- Supports long, short, and HT preamble modes

[1] This frequency depends on external delays also.
[2] Usage of these pins is possible in customized software.

- High-performance multipath compensation in OFDM, DSSS, and CCK modes

1.3.3: RF

- Highly integrated 2.4 GHz transceiver and Power Amplifier with direct conversion architecture
- Integrated frequency reference and antenna

1.4: Networking Protocols

- SLIP
- ARP

1.5: Configuration

The RS9110-N-11-21 module can be configured through UART or SPI. The following are some of the commands that can be given to the module:

- Scan
- Connect
- Pre-shared Keys
- SSID of hidden WLAN networks
- Create/Join an IBSS network

1.6: Coexistence

- Hardware for BT coexistence with two-wire interface present in system
- Flexible BT coexistence through 3-wire hardware interface
- Software will be available in future software upgrades

1.7: Software

- Sample Host driver for SPI on Linux
- Configuration and management GUI for Windows XP for UART
- Embedded software for complete WLAN functionality including 802.11n aggregation and Block-ACK, auto rate adaptation, security, and QoS modes[3]

1.8: Compliance and Certification

- Reference design certified for Wi-Fi 802.11n, WMM, WMM-PS, WPS, and Voice-Personal
- Reference design is FCC, IC, and CE certified
- RoHS (Restriction of Hazardous Substances) compliant

[3] Please refer to the in Release Notes included with the firmware/software release to know what features are supported in the present release.

2: Pin Description

2.1: Module Pinout

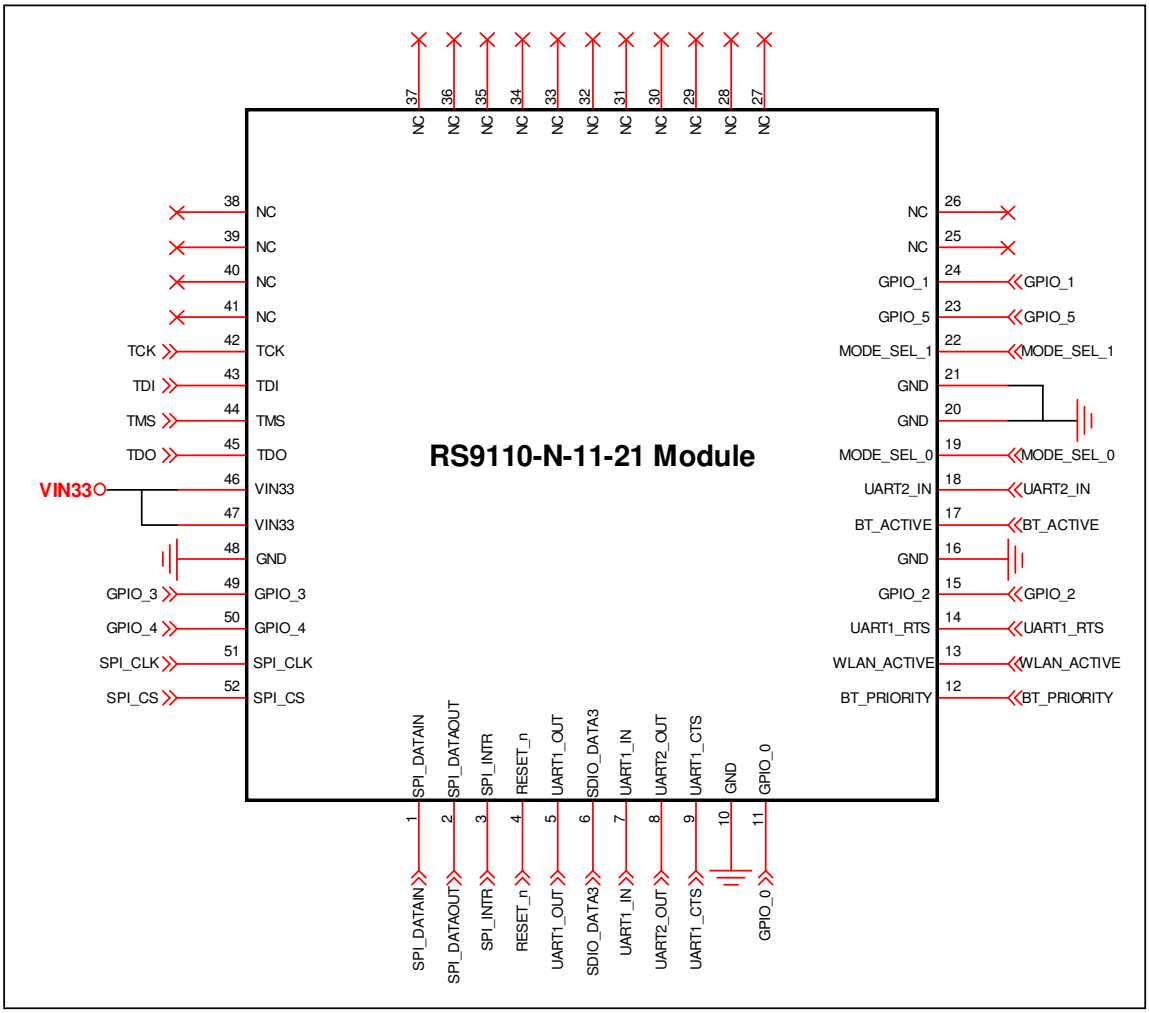

Figure 1: Pinout of the Module

2.2: Pin Description

Pin No.	Pin Name	Pin Type	Description
1)	SPI_DATAIN	Input	SPI Data Input
2)	SPI_DATAOUT	Output	SPI Data output
3)	SPI_INTR	Output	Interrupt to the host. Active high, level triggered
4)	RESET_n	Input	Power-on reset
5)	UART1_OUT	Inout	UART Port1 output. In case of SPI

Pin No.	Pin Name	Pin Type	Description
			host interface mode, this pin is configured as an unused GPIO.
6)	SDIO_DATA3	Inout	This pin is used for internal debug purposes. Recommended to be left open
7)	UART1_IN	Inout	UART Port1 input. In case of SPI host interface mode, this pin is configured as an unused GPIO.
8)	UART2_OUT	Inout	UART Port2 output. Recommended to be left unconnected, and can be reconfigured to be a GPIO in custom offerings.
9)	UART1_CTS	Inout	UART Port 1 CTS. Recommended to be left unconnected, and can be reconfigured to be a GPIO in custom offerings.
10)	GND	Ground	Ground
11)	GPIO_0	Inout	GPIO Pin 0. Unused in the default offering, and recommended to be left open
12)	BT_PRIORITY	Inout	Indicates through a 'logic high' that BT is transmitting high priority traffic. When BT coexistence is not used, this pin should be connected to ground. This pin can be configured as a GPIO also in custom offerings.
13)	WLAN_ACTIVE	Inout	This indicates that WLAN activity is in progress. When low, BT device has the opportunity to transmit. This pin can be configured as a GPIO also in custom offerings.
14)	UART1_RTS	Inout	UART Port 1 RTS. Recommended to be left unconnected, and can be reconfigured to be a GPIO in custom offerings.
15)	GPIO_2	Inout	GPIO Pin 2. Unused in the default offering, and recommended to be left open
16)	GND	Ground	Ground
17)	BT_ACTIVE	Inout	This signal may be used by an external Bluetooth device to indicate its activity or impending

Pin No.	Pin Name	Pin Type	Description
			activity. This signal is not used in the default BT coexistence firmware. This pin can be configured as a GPIO in custom offerings.
18)	UART2_IN	Input	UART Port2 input. Recommended to be left unconnected, and can be reconfigured to be a GPIO in custom offerings.
19)	MODE_SEL_0	Input	Internal debug purposes. Connect pull up of 100KOhms.
20)	GND	Ground	Ground
21)	GND	Ground	Ground
22)	MODE_SEL_1	Input	SPI Mode: Connect pull down of 4.7KOhms. UART Mode: Connect pull up of 100KOhms
23)	GPIO_5	Inout	GPIO Pin 5. Unused in the default offering, and recommended to be left open
24)	GPIO_1	Inout	GPIO Pin 1. Unused in the default offering, and recommended to be left open
25)	NC	-	No Connect
26)	NC	-	No Connect
27)	NC	-	No Connect
28)	NC	-	No Connect
29)	NC	-	No Connect
30)	NC	-	No Connect
31)	NC	-	No Connect
32)	NC	-	No Connect
33)	NC	-	No Connect
34)	NC	-	No Connect
35)	NC	-	No Connect

Pin No.	Pin Name	Pin Type	Description
36)	NC	-	No Connect
37)	NC	-	No Connect
38)	NC	-	No Connect
39)	NC	-	No Connect
40)	NC	-	No Connect
41)	NC	-	No Connect
42)	TCK	Input	JTAG Test Clock to the RS9110
43)	TDI	Input	JTAG Test Data In
44)	TMS	Input	JTAG Test Mode State
45)	TDO	Output	JTAG Test Data Out
46)	VIN33	Power	3.3V Power Supply
47)	VIN33	Power	3.3V Power Supply
48)	GND	Ground	Ground
49)	GPIO_3	Inout	GPIO Pin 3. Unused in the default offering, and recommended to be left open
50)	GPIO_4	Inout	GPIO Pin 4. Unused in the default offering, and recommended to be left open
51)	SPI_CLK	Input	SPI Clock input
52)	SPI_CS	Input	Active low SPI Chip Select

Table 1: Pin Description

Notes:

- Some interfaces are not used in the default configuration or mode of operation. These may be used in custom applications with appropriate firmware.
- The Bluetooth coexistence interface (BT_PRIORITY, WLAN_ACTIVE, BT_ACTIVE), UART1_RTS, UART1_CTS, UART2_OUT, UART2_IN are also general purpose I/O signals and may be reprogrammed to be inputs or outputs as needed. The UART1_IN and UART1_OUT may be programmed as GPIO in case SPI is used as the Host Interface.

- Please contact Redpine Signals for application notes or for customization of a solution.

3: Electrical Characteristics

3.1: Absolute Maximum Ratings

Absolute maximum ratings in the table given below are the values beyond which the device could be damaged. Functional operation at these conditions or beyond these conditions is not guaranteed.

Parameter	Symbol	Value	Units
Input Supply voltage	Vin	3.6	V
Supply voltage for I/O Rail	DVDD33	3.6	V
Supply Voltage for the RF	VRF33	3.6	V
RF Input Level	RFIN	10	dBm
Storage temperature	T_{store}	-65 to 150	°C
Electrostatic discharge tolerance (HBM)	ESD_{HBM}	2000	V
Electrostatic discharge tolerance (MM)	ESD_{MM}	200	V
Electrostatic discharge tolerance (CDM)	ESD_{CDM}	500	V

Table 2: Absolute Maximum Ratings

3.2: Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Input Supply voltage	V_{IN}	3.1	3.3	3.6	V
Ambient temperature	T_a	-40	25	85	°C

Table 3: Recommended Operating Conditions

3.3: DC Characteristics – Digital I/O Signals

Parameter	Min.	Typ.	Max.	Units
Input high voltage	2	-	3.6	V
Input low voltage	-0.3	-	0.8	V
Output low voltage	-	-	0.4	V
Output high voltage	2.4	-	-	V
Input leakage current (at 3.3V or 0V)	-	-	±10	µA
Tristate output leakage current (at 3.3V or 0V)	-	-	±10	µA

Table 4: Input/Output DC Characteristics

3.4: AC Characteristics – Digital I/O Signals

3.4.1: JTAG Interface of the RS9110

Parameter	Symbol	Min.	Typ.	Max.	Units
RS_TCK frequency	Fjtag	0		25	MHz
RS_TDI, setup time	Tstdi	5	-	-	ns
RS_TDI, hold time	Thtdi	5	-	-	ns
RS_TMS, setup time	Tstms	5	-	-	ns
RS_TMS, hold time	Thtms	5	-	-	ns
RS_TDO, clock to output valid	Totdo	0	-	14	ns

Table 5: AC Characteristics – JTAG Interface

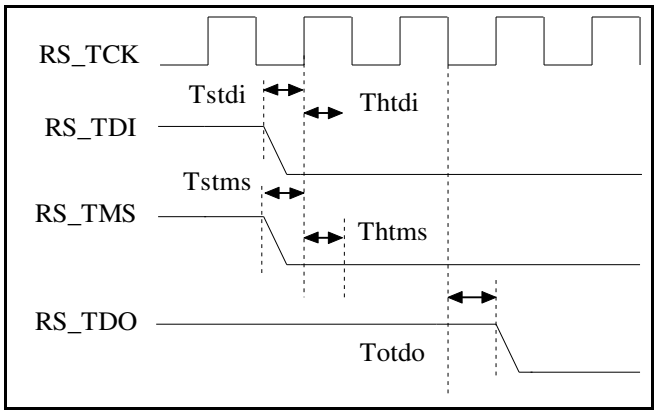

Figure 2: Interface Timings – JTAG Interface

3.4.2: SPI Interface

3.4.2.1: Full Speed Mode

Parameter	Symbol	Min.	Typ.	Max.	Units
SPI_CLK	Tspi	0		25	MHz
SPI_CS to output valid	Tcs	3.5	-	8.5	ns
SPI CS setup time	Tcst	2	-	6	
SPI_MOSI setup time	Tsd	1	-	4	ns
SPI_MOSI hold time	Thd	1	-	2	ns
SPI_MISO clock to output valid	Tod	4	-	9.25	ns

Table 6: AC Characteristics – SPI Interface Low-speed Mode

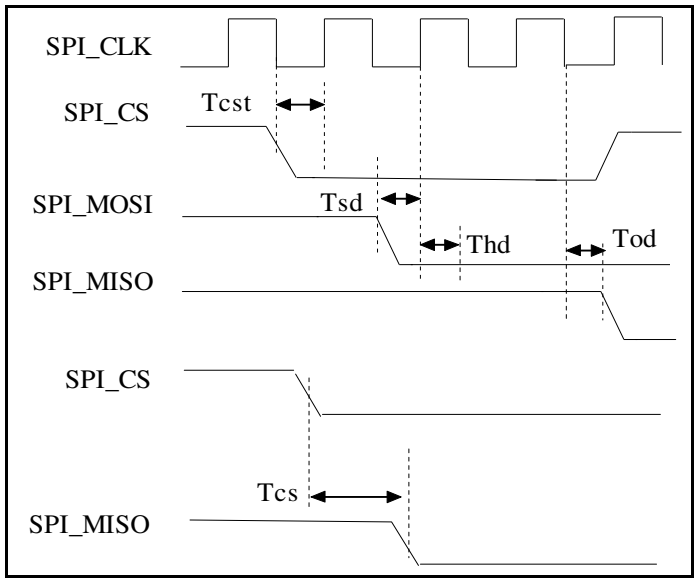

Figure 3: Interface Timings – SPI Interface Low-speed Mode

3.4.2.2: High Speed Mode

Parameter	Symbol	Min.	Typ.	Max.	Units
SPI_CLK	Tspi	0	-	80	MHz
SPI_CS to output valid	Tcs	3.5	-	8.5	ns
SPI CS setup time	Tcst	2	-	6	
SPI_MOSI setup time	Tsd	1	-	4	ns
SPI_MOSI hold time	Thd	1	-	2	ns
SPI_MISO clock to output valid,	Tod	4	-	9.25	ns

Table 7: AC Characteristics – SPI Interface High-speed Mode

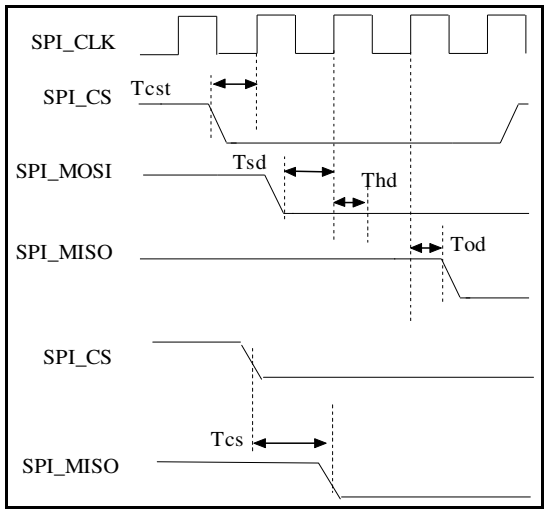

Figure 4: Interface Timings – SPI Interface High-speed Mode

4: Performance Specifications

4.1: Wireless Specifications

Feature	Description
Frequency Band	2.400 – 2.500 GHz (2.4 GHz ISM band)
Modulation	OFDM with BPSK, QPSK, 16-QAM, and 64-QAM 802.11b with CCK and DSSS
Supported Data Rates	802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps 802.11a/g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps 802.11b: 1, 2, 5.5, 11 Mbps
802.11n Features	MCS 0-7, STBC, RIFS, Greenfield Protection A-MPDU, A-MSDU Aggregation with Block-ack, PSMP, and MTBA
Typical Transmit Power (+/- 2 dBm)	17 dBm for 802.11b DSSS 17 dBm for 802.11b CCK 15 dBm for 802.11g/n OFDM

Table 8: Wireless Specifications

4.2: Standards Compliance

RS9110-N-11-22 is compliant with the requirements of IEEE 802.11b, 802.11g and 802.11n that include the following:

- Transmit Spectral Mask
- Transmit Center Frequency Leakage
- Transmit Center Frequency Accuracy
- Symbol Clock Frequency Tolerance
- Transmit Constellation error
- Receiver Adjacent Channel Interference Rejection
- Receiver Non-adjacent Channel Rejection
- Receiver Minimum Input Level
- Receiver Maximum Input Level

5: Software Architecture Overview

The following figure depicts the software architecture of the RS9110-N-11-21 module.

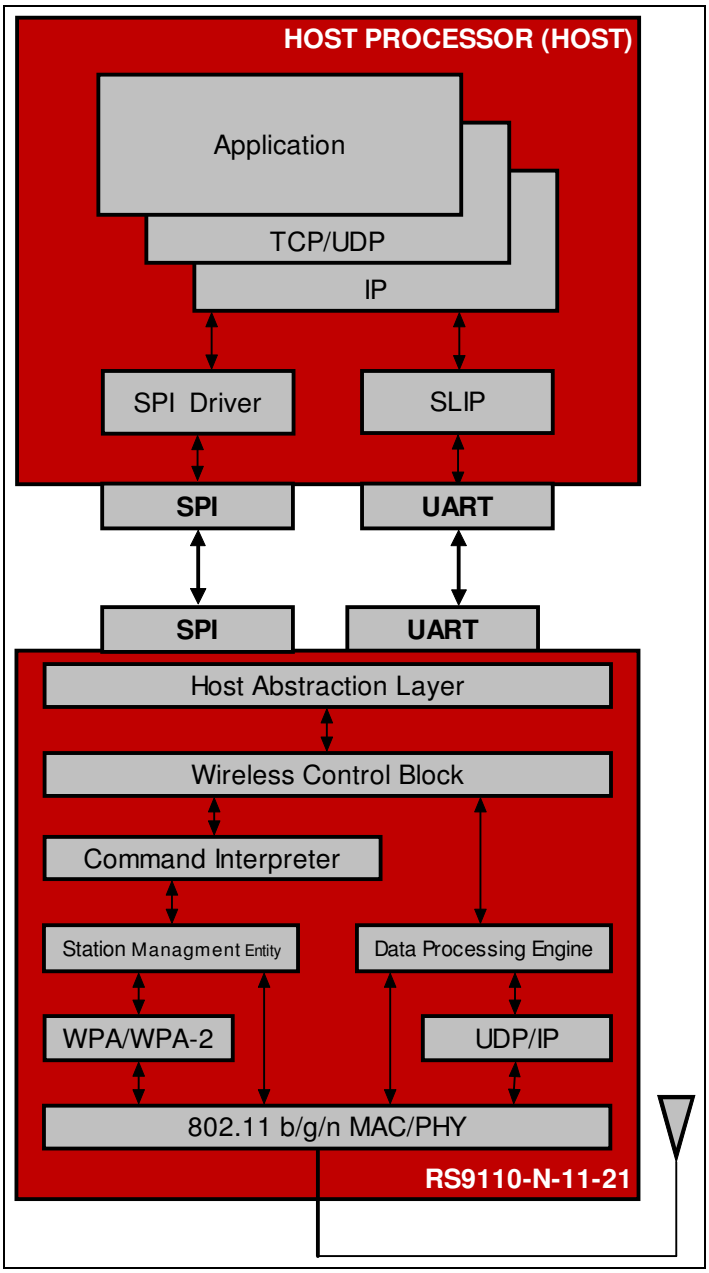

Figure 5: RS9110-N-11-21 Software Architecture Block Diagram

As shown in the figure above, the RS9110-N-11-21 module is integrated with the Host using either UART or SPI interfaces. The transmission and reception of the data to/from the Host depends on the interface used to connect the module as briefed below.

UART mode

The Host should transmit/receive IP packets using SLIP interface when RS9110-N-11-21 is configured for UART mode.

SPI mode

Host should transmit/receive 802.3 packets when RS9110-N-11-21 is configured for SPI mode. A thin driver on the Host takes care of interacting with the Wi-Fi module through the SPI Host interface.

The following sections explain in brief the various components illustrated in Figure 9.

5.1: Host

The Host is any system that has a full-fledged TCP/IP stack and either a UART or SPI interface.

5.1.1: SLIP

The SLIP (Serial Line Internet Protocol) layer on the Host establishes a point-to-point serial network link with the RS9110-N-11-21 module. This helps to carry the IP data over the serial port to the RS9110-N-11-21. Host transmits/receives the IP packet to/from the module. The Host must have the support for SLIP interface configuration to interact with RS9110-N-11-21 module in UART mode.

5.1.2: UART

The UART on the Host side acts as the physical layer of the TCP/IP stack carrying SLIP-encapsulated frames. The UART is also used to configure various parameters of RS9110-N-11-21.

5.1.3: SPI

The SPI on the Host side acts as the physical layer of the TCP/IP stack carrying Wi-Fi specific frames. SPI on the Host acts as the master.

5.1.4: Thin SPI Driver

The SPI driver on the Host is a thin network driver through which the TCP/IP stack interacts with the Wi-Fi module. The driver uses the SPI host controller driver on the Host to send/receive the data to/from the RS9110-N-11-21 module over the SPI interface.

5.2: RS9110-N-11-21

The RS9110-N-11-21 module incorporates all Wi-Fi functionality to act as a serial to Wi-Fi Bridge. It handles all the wireless network connectivity. The following sections describe the software components of the RS9110-N-11-21 module in brief.

5.2.1: SPI

The SPI on the RS9110-N-11-21 acts the SPI slave. It is a standard 4-wire SPI and can support a maximum frequency of 80MHz.

5.2.2: UART

The UART on the RS9110-N-11-21 module is the physical layer which transmits/receives the data from the Host. It supports variable baud rates from 9600 to 3686400 bps.

5.2.3: Host Abstraction Layer (HAL)

The HAL abstracts the lower layers in the host interface with which the RS9110-N-11-21 module is connected. The HAL interacts with the Wireless Control Block layer for the processing of the frames obtained from or destined to the Host.

5.2.4: Wireless Control Block (WCB)

The data from/to the Host is classified as a control frame, an IP/802.3 frame or an application data frame. The WCB layer processes the frame obtained and acts accordingly. The functionality of the WCB module depends on the type of the frame, direction of the frame and the mode on which RS9110-N-11-21 is configured (UART or SPI) as described below.

5.2.4.1: Transmit Direction

In the transmit direction, the WCB layer either interacts with the AT command interpreter or the data processing engine depending on the type of the frame.

UART Mode: In UART mode, the WCB module receives SLIP-encapsulated data/control frames from the Host in the transmit path.

SPI Mode: In SPI mode, the WCB module receives data/control frames from the Host in the transmit path.

5.2.4.2: Receive Direction

In the receive direction, the WCB layer interacts with the HAL to transmit frames to the Host.

UART Mode: In UART mode, the WCB module receives SLIP-encapsulated data/response frames from the Station Management Entity or the Data Processing Engine in the receive path.

SPI Mode: In SPI mode, the WCB module receives data/response frames from the Station Management Entity or the Data Processing Engine in the receive path.

5.2.5: Command Interpreter

The control information from the Host is interpreted by the AT command interpreter. The AT command interpreter sets or gets the values of various configurable parameters for providing the Wi-Fi access.

5.2.6: Station Management Entity (SME)

The SME is the core layer which manages the Wi-Fi connectivity. The SME maintains the state machine to detect the activity on the Wi-Fi network and indicates to the user accordingly. It also performs re-association to the

configured access point in Infrastructure mode. It interacts with the WPA supplicant if Security is enabled in the Wi-Fi network.

5.2.7: WPA Supplicant

The WPA supplicant is used to initiate the 802.1x/EAP authentication if WPA/WPA2-PSK is used as the security parameter. It also plays a major part in performing the 4-way handshake to derive the PTK in WPA/WPA2-PSK modes. Only AES mode is supported in the current version.

5.2.8: Data Processing Engine (DPE)

The DPE processes data obtained from the Host or from the network. The functioning of the DPE depends on the direction and type of the frame.

If the frame obtained from the Host is an IP packet, then the packet is delivered to the ARP layer for the ARP resolution to be done.

If the frame is obtained from the network, the DPE encapsulates the data using the SLIP protocol before delivering the packet to the Host over the UART.

6: Ordering Information

6.1: Contact Information

For additional information, please contact Sales at Redpine Signals, Inc.

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San Jose, CA 95131 USA

Phone: +1 408 748 3385

E-mail: sales@redpinesignals.com

Website: http://www.redpinesignals.com/

6.2: Device Ordering Information

The following table lists the part numbers to be used for ordering modules or evaluation boards (EVB). The 'xx' in the part numbers indicate a version number – 01, 02, etc., - identifying the version of the custom firmware that is included with the module or EVB. Redpine can create and provide customized firmware based on user requirements.

Device Number	Description	Packaging	Qualification
RS9110-N-11-21-0	Standard Part	Tray	Industrial
RS9110-N-11-21-1	Standard Part	Tape and reel	Industrial
RS9110-N-11-21-01-0	Part with firmware for SPI as Host Interface	Tray	Industrial
RS9110-N-11-21-01-1	Part with firmware for SPI as Host Interface	Tape and reel	Industrial
RS9110-N-11-21-02-0	Part with UART as Host Interface and external antenna connector	Tray	Industrial
RS9110-N-11-21-02-1	Part with UART as Host Interface and external antenna connector	Tape and reel	Industrial
RS9110-N-11-21-03-0	Part with SPI as Host Interface and external antenna connector	Tray	Industrial

RS9110-N-11-21-03-1	Part with SPI as Host Interface and external antenna connector	Tape and reel	Industrial
RS9110-N-11-21-xx-0	Part with custom firmware	Tray	Industrial
RS9110-N-11-21-EVB	Evaluation board for standard part	Board	
RS9110-N-11-21-02-EVB	Evaluation board for part with firmware for UART as Host Interface and external antenna connector	Board	
RS9110-N-11-21-03-EVB	Evaluation board for part with firmware for SPI as Host Interface and external antenna connector	Board	
RS9110-N-11-21-xx-EVB	Evaluation board for part with custom firmware	Board	

Table 9: Device Ordering Information

6.3: Collateral

The following documentation and software are available along with the RS9110-N-11-21 module.

- Evaluation Board (EVB) for Serial interface
- Embedded firmware for WLAN
- AT Command Interface & SLIP Encapsulation & Decapsulation software for Windows
- Reference SPI driver for Linux
- EVB User Guide
- Reference schematics and layout guidelines

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